

The Process of Scientific Inquiry

Lesson Plan Number 1

<http://bumbleboosters.unl.edu/>

"To make a prairie it takes one clover and a bee and reverie." Emily Dickinson

Overview: Scientists answer questions about the world they live in by formulating hypotheses and designing experiments to test them. Formulating a hypothesis and designing an experiment to test it are the first steps in all scientific inquiry. This lesson is a "warm up exercise" for participation in Bumble Boosters. It is designed to develop critical thinking skills. This lesson will require students to formulate and test hypotheses, to identify variables that can affect their results and to analyze the results of their experiments. Students are guided to learn why randomization and replication are used in experiments to reduce the risks of drawing inaccurate conclusions.

Project: Groups of students will determine the distance from which they can hit 50% of the targets they shoot at with squirt guns. They will then identify variables that can affect their experimental results and formulate testable hypotheses about the effect of one variable. Groups will then be given an opportunity to redesign their experiment to reduce variability in their results. Finally, the results of all groups will be compiled to estimate the distance from which high school students can hit a target 50% of the time.

Vocabulary: hypothesis, variable, randomization, replication

Educational Goals:

1. To develop critical thinking skills.
2. To recognize sources of variation in an experiment.
3. To formulate and test hypotheses.

Scientific Goals:

1. To provide students experience in the process of scientific inquiry.
2. To build a foundation for subsequent lessons.
3. To experience collaborative research and discovery.

Materials Needed: Two squirt guns, one Styrofoam block (24" x 4"), ten golf tees, ten ping pong balls, one tape measure, one pencil, one data sheet. One set of materials will be needed for each group of students.

Introduction: The processes used in this lesson are similar to those a scientist at a pharmaceutical company would use in determining the dosage recommendations for a new product. Students will

determine the distance from which they can hit a target 50% of the time. Similarly, a scientist might be interested in the amount of a drug that will cure a headache 50% of the time. All scientific inquiry follows a similar protocol. A question is identified, and an experiment is designed to answer the question. Variables are identified and addressed to improve the precision of the experiment.

The Lesson:

1. Each group should select a recorder, a measurer, and a shooter or shooters.
2. Push ten golf tees into the Styrofoam block, and position a ping pong ball on each tee.
3. Measure distances of 1, 3, 6, 9, 12 and 15 feet from the Styrofoam block.
4. Each group should then shoot at the ping pong balls 10 times from each distance. Score the shot as a hit if the ball is knocked from the tee. After ten shots, replace any balls that have been knocked from their tees. Record the hits from each distance.
5. Plot your data with distance on the X axis and the number of hits on the Y axis. Now draw a line that best fits your data points. Now draw a horizontal line from five hits on the Y axis. The point where your "best-fit line" and the horizontal line intersect is your estimated distance for hitting the target 50% of the time.
6. Discuss variables that could influence results. Some examples include the following: Was wind a factor? Did shooters all use the same gun? Did shooters practice? Were shooters male or female? Make a list of all the variables that can influence the results.
7. Formulate null (no effect) and alternative hypotheses about one of the variables identified by the group. For example:

Null hypothesis - male shooters are not more accurate than female shooters.

Alternative hypothesis - Male shooters are more accurate than female shooters.

8. Test your hypothesis by controlling the variable you identify and shooting again at the 50% hit distance that you calculated in step 6. Compare your original data with the data you obtained by limiting the effect of one of the variables.
9. Finally, take the original estimates of all groups and calculate an average distance for hitting the target 50% of the time for your class.

Conclusion:

1. Would you expect the same results if a high school science class in California repeated your experiment? Why?
2. Would you expect the same results if a fourth grade class in Maine repeated your experiment? Why?
3. Describe what inferences you can draw from your experiment, and define the population to which your inferences apply.
4. List the variables that students tested. Which variables appear to have an impact on the results?